United States
Department of
Agriculture

Agricultural
Cooperative
Service

ACS
Research Report
Number 51

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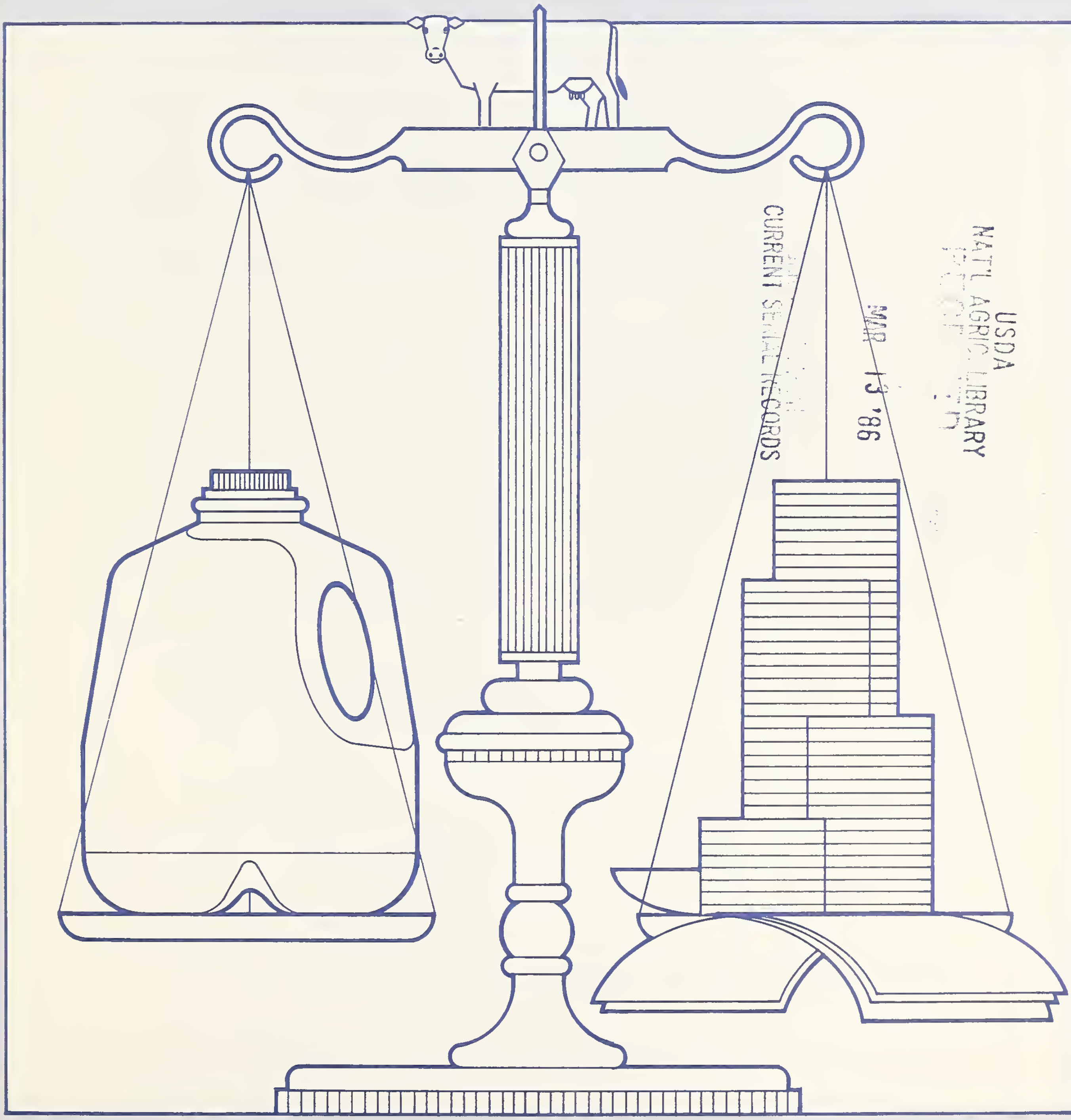

A Reserve-Balancing Pool for Services by Dairy Cooperatives

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U.S. Department of Agriculture
ACS Research Report 51

Abstract

The rationale for compensating dairy cooperatives for the costs incurred in balancing milk supply for the fluid market is examined. A reserve-balancing pool is proposed to facilitate deducting supply-balancing service credit from a marketwide producer pool and making payment to cooperatives for providing the services. The volume of necessary reserves maintained for the fluid market determines the size of the reserve-balancing pool. A dairy cooperative qualifies for pool payment based on the volume of milk delivered for fluid uses and on the volume of necessary reserves actually balanced. An alternative qualification is to allocate the volume of necessary reserves each cooperative has to balance according to a cooperative's market share of milk for fluid and other uses.

Key words: Cooperative, milk, reserve-balancing pool, seasonality, manufacturing costs, marketwide services

August 1985

Preface

The issue of compensating dairy cooperatives for their supply-balancing services for the market has been a subject of increasingly intense debate in recent years. Conventional wisdom would provide a credit from the marketwide producer pool to balancing plants performing these services. Difficulties arise with determining if the variations in milk receipts at the balancing plant for manufacturing actually represent volume variability from the fluid market. The approach also tends to encourage decentralized balancing, which requires greater aggregate balancing capacity and increases a variety of balancing costs. (See, for example, *8*, p. 78, in the References.)

This study suggests a reserve-balancing pool to resolve the issue. This approach is based on balancing services actually needed by the fluid market. The ideal arrangement will compel dairy cooperatives to deliver milk for fluid uses and encourage performing bona fide balancing services with the most efficient plant operations.

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Highlights

Modern technology has made the dairy industry more dynamic. Milk movement now requires wider area coordination. Dairy cooperatives have assumed most of the functions of primary procurement and shipping coordination. The responsibility for balancing daily and seasonal fluctuations in the volume of milk supply and demand falls largely on cooperatives. Of course, some noncooperative handlers still do their own procurement, movement, and balancing. Therefore, the analysis in this report, although it focuses on dairy cooperatives, applies equally to other handlers where appropriate. Furthermore, some cooperatives also operate fluid processing plants and play a dual role of fluid handlers and raw milk suppliers.

The report explains the concept of supply balancing for the fluid market by pinpointing the volume of reserves necessary for satisfying fluid demand. A reserve-balancing pool is proposed to account for the costs of balancing this volume of milk and pay dairy cooperatives for the services they provide.

Necessary reserves include both operating and seasonal reserves. The volume of operating reserves is the milk that is necessary to ensure a sufficient supply for the surge in peak demand. This volume also includes a provision for fluid product returns and shrinkage normally encountered by fluid handlers. This study proceeds with the assumption that the volume of operating reserves is 10 percent of fluid demand.

To satisfy fluid demand and maintain a minimum volume of operating reserves for the surge in demand in the peak fluid consumption month in the fall, certainly more milk will be produced than required for fluid demand and operating reserves during other times of the year because of the seasonal nature of both milk production and fluid consumption. Seasonal reserve volume is zero during the peak demand month and is the highest during the spring flush. The volume of operating and seasonal reserves is the minimum volume of reserves that fluid handlers have to carry if they procure their own milk and balance their own supplies. Milk in excess of fluid demand and necessary reserves is defined as excess reserves.

A hypothetical market is used to demonstrate reserve requirements. The market is given a prescribed set of indices of seasonality of milk production and fluid consumption. Daily average milk production is 10 million pounds, and fluid consumption, 5 million pounds. In this market, the volume of necessary reserves is determined to be 23.3 percent of fluid demand. It ranges from 10 percent of fluid demand in November (operating reserves only) to 38.2 percent in June.

The peak volume of necessary and excess reserves is 6.050 million pounds per day in June. Processing this volume requires two butter-powder plants, each with a daily manufacturing capacity of 3.025 million pounds. An estimated average of 5.1 cents per hundredweight of fluid demand, ranging from zero in June to 9.3 cents in November, is required to cover increases in the fixed and overhead costs and the inplant manufacturing costs because the plants are required to handle the fluctuating volume of necessary reserves. These are the costs of balancing necessary reserves. They translate into a weighted average of 22.1 cents per hundredweight of necessary reserves with a range from zero in June to 92.8 cents in November.

The costs of balancing necessary reserves are deducted as reserve-balancing credits from the fluid differential in the marketwide producer pool. A reserve-balancing pool is created to receive these credits and pay the three cooperatives in the market for providing reserve-balancing services. Payments are based on the fluid sales and the services actually provided by each cooperative. A requirement of a minimum manufacturing capacity during a pool payment month may be necessary to protect the integrity of the reserve-balancing pool. An alternative reserve-balancing pool payment system is based on a cooperative's market share of milk for fluid and other uses, rather than just fluid sales.

This study was based on a hypothetical market with three dairy cooperatives supplying all the milk. Milk volume and utilization, and their seasonalities are different for each cooperative. Supply-balancing operations are assumed to be done in butter-powder plants. They also can be done in cheese plants or other manufacturing plants in some markets.

A different set of data on milk volumes and costs might change the findings. Application of the reserve-balancing pool to a specific market requires a careful analysis of the reserve-balancing services needed by the market.

A Reserve-Balancing Pool for Services by Dairy Cooperatives

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Technological advances have brought tremendous changes in the dairy industry. Milk production is now mostly a specialized enterprise of commercial farming. The technological development with the most important impact on milk marketing was bulk tank handling of raw milk. It changed milk handling procedures and made the milk market much more dynamic. Milk was no longer tied to locations near where it was produced and could be easily moved to plants much farther away.

In earlier days, cooperatives in the business of marketing raw milk were largely bargaining cooperatives. They bargained with fluid handlers over milk prices and other terms of trade. Handlers received milk from farms on their respective hauling routes. They were responsible for all milk and for disposing of milk receipts in excess of fluid demand.

With the shift to bulk handling of milk, a major change came also in the roles of cooperatives and handlers. Cooperatives became increasingly responsible for raw milk handling. With increased mobility as a result of bulk handling, much of the milk could be moved directly from the farm to the market. Because of economies of scale, it was more efficient and less costly for one or a few agencies to coordinate milk movement to the market and balance the reserves, than for handlers to procure their own milk and dispose of excessive volume. Dairy cooperatives have taken over most of the functions of procuring raw milk, coordinating raw milk movement, and balancing the reserves. Many fluid milk handlers have entered into a full supply arrangement with a dairy cooperative that provides full services to the handlers. Moving from individual toward a more aggregate balancing reduces volume variability and reserve balancing problems and provides a mechanism for meeting the remaining fluctuation in demand.

Reserve supply for peak demand usually can be maintained at a considerable distance from the fluid processing plant. Only infrequently will this milk need to be physically moved to the fluid processor. A single balancing plant can handle the reserves for an area considerably larger than the usual procurement area for a specific fluid processing plant. A supply-balancing plant will provide the milk as needed for fluid uses by those processing plants that are regular customers. Additional sales may be made as spot sales. This leaves the balancing plant absorbing fluctuations in farm production, assembly, demand for fluid, and other uses by regular outlets, variation in spot sales, and in other transfers. In other words, balancing plants have no regular volume; they utilize the milk left over from other uses. They also provide supplementary supplies to customers as needed.

The supply-balancing function is now mostly performed by cooperatives that provide full services to handlers. While it is more efficient and less costly for one or a few cooperatives in the market, rather than each handler, to perform the function of balancing supplies with demand and handle the reserve supplies of milk, it is nevertheless a function that must be done by someone, and one that can only be done at a cost to whoever does it.

Costs attributed to supply-demand balancing and coordination operations include extra costs of hauling milk to short-supply areas and diverting reserve supplies to balancing plants, costs of bulk storage used to hold milk supplies to meet peak demand days, personnel and office expenses involved in delivery coordination and routing bulk-tank trucks, shrinkage resulting from splitting loads and reloading to divert milk to balancing plants, general administration attributed to the function of coordinating supplies, health and quality inspection fees on reserve milk, and plant give-up costs. These services focus on the market and have the purpose of improving marketing efficiency, improving resource allocation, and providing more orderly marketing.

Some of the services provided at the market level are specific to fluid handlers. These services may be provided by the handler or the handler may purchase them from cooperatives who sell raw milk. Cooperatives may be properly compensated for providing these handler-specific services. Compensating cooperatives for these services depends largely on accurate accounting. Other market level services or marketwide services do not have a specific, well-identified beneficiary or group of beneficiaries. If the services are provided, many individuals and groups (producers, handlers, and consumers) may benefit, regardless of whether they pay for any part of the cost of the services. It may be impossible to restrict beneficiaries to those who pay for the cost of services. But it is also difficult to determine the proper compensation to cooperatives for the costs of providing such services (*6*), (*2*), (*3*), and (*1*).[1]

[1]Italicized numbers in parentheses refer to the references at the end of this report.

One of the heaviest costs of marketwide services is owning and operating supply-balancing plants. Cooperatives have not been properly compensated for this function and the issue has been controversial in recent years. One of the problems in properly compensating for balancing services is determining what volume of a plant's operations is for manufacturing the reserve milk supply. The other problem is finding usable plant cost data for determining the costs of manufacturing the volume of milk reserves. As a result of providing the function of reserve balancing, a manufacturing plant faces a situation where milk volume tends to fluctuate more and plant costs tend to be higher as compared to a plant without reserve balancing functions.

The key to solving the first problem is in determining the volume of necessary milk reserves (operating and seasonal reserves) for ensuring an adequate supply to satisfy the demand of the fluid market. This study proposes a method that might be pragmatic enough for practical application.[2] Recent ACS dairy product manufacturing cost studies provide a data base for determining the costs of manufacturing necessary milk reserves (*4*) and (*5*). Insights gained in these two aspects of balancing operations help provide a way to compensate cooperatives for balancing services for the fluid market. A hypothetical market is used to illustrate the analysis in this study.

SEASONAL NATURE OF MILK PRODUCTION AND FLUID CONSUMPTION

The index of seasonality of milk production in the hypothetical market is presented in table 1. The seasonal index shows March, April, May, and June are usually the highest milk-producing months, with May being the peak. The index of 110 indicates average daily production in May is 10 percent higher than annual average daily production (average index = 100). Production declines sharply from June to July and stays relatively low throughout summer and fall. Production is usually lowest in November. With an index of 93, November is 7 percent below annual average daily production. Production recovers in December and increases steadily through winter and spring until it peaks again in May. The May peak to November trough is a drop of 17 percentage points, based on average daily production. On an actual daily production basis, the peak to trough discrepancy would have been even greater.

The seasonal pattern of fluid demand is quite different (table 1). Fluid demand is high in September and maintains this high level through fall and winter. It peaks in November (seasonal index = 104), which is 4 percent above annual average daily consumption (average index = 100). Fluid demand dips in December and declines steadily from February. The lowest fluid demand month is July. With an index of 92, it is 8 percent below the annual daily average. The July low is a drop of 12 percentage points compared with the November peak. Beside the annual cycle of fluid uses, processing plants have a weekly cycle of fluid demand. Typically, fluid processing plants do not operate 7 days a week. Their receipts of fluid milk tend to gear to their operating schedules (*7*).

The weekly variation of fluid demand by processing plants may resemble the series presented in table 2. Sunday fluid demand is 8 percent of the weekly total fluid demand. The demand for Wednesday increases to 17.3 percent of weekly total. Demand drops sharply on Thursday but peaks on Friday. Saturday fluid demand is almost equal to weekly average daily demand. Expressed as a percent of weekly

Table 1—Indices of seasonality of milk production and fluid demand

Month	Milk production	Fluid demand
	Percent	
January	98	103
February	99	102
March	104	101
April	108	98
May	110	100
June	109	97
July	98	92
August	96	95
September	96	103
October	94	103
November	93	104
December	95	102
Average	100	100

Table 2—Handlers' weekly cycle of fluid milk demand, an average week in May

Day	Share of weekly demand	Weekly cycle index
	Percent	
Sunday	8.0	56
Monday	13.2	93
Tuesday	16.9	119
Wednesday	17.3	121
Thursday	11.8	82
Friday	18.4	128
Saturday	14.4	101
Average	14.3	100

[2]The process of determining operating milk reserves in (*2*) and (*3*) was much too complex and required too much detailed information to be practical. Modification is needed for the process of determining seasonal milk reserves in (*7*).

average daily demand, indices of daily demand are also listed in table 2. The index for Sunday is 56; Wednesday, 121; Thursday, 82; Friday, 128; Saturday, 101.

Within the weekly cycle, day-to-day fluctuation of fluid demand does not have an adverse effect on the operations of fluid processing plants or supply-balancing plants. This is true as long as the plants at both ends of the marketing channel have sufficient holding capacity to roll the raw milk stocks while maintaining product quality and use up available milk each week. The major task in this situation is the coordination of hauling operations (*5*, pp, 16-18).

It is the week-to-week and month-to-month fluctuations of fluid demand that poses the principal problem for the supply-balancing plant, especially with respect to its required manufacturing capacity and plant operations.

NECESSARY RESERVES TO ENSURE SUFFICIENT MILK SUPPLY FOR SATISFYING FLUID DEMAND

Two categories of milk reserves, operating and seasonal, are required to meet fluid needs. Operating reserves satisfy fluid demand of the peak week, while seasonal reserves are necessary because of the seasonal nature of milk production and fluid milk demand (table 3).

Operating Reserves

Operating reserves include the reserves that ensure a sufficient supply for the peak week of fluid demand by processing plants, as there are week to week variations in such demand. The reserves also are necessary to cover shrinkage and returns of packaged products ordinarily experienced by processing plants. Some reports put the operating reserves at 6 percent of daily average fluid sales. Others argue that the percentage should be as high as 20 percent. This study adopts a rate of 10 percent operating reserves over the volume of fluid demand.

In table 3, operating reserves are set at 10 percent of fluid demand every month. Therefore, operating reserves follow the same seasonal pattern as fluid demand. The low is 0.46 million pounds per day in July and the high is 0.52 million pounds in November, with the yearly average being 0.5 million pounds a day.

Seasonal Reserves

Milk production is high in spring and low in fall. This is opposite of fluid demand, which is lower in spring and higher in fall. If producers supplying the market raise sufficient number of cows to produce enough milk to fully satisfy the highest fluid demand and operating reserves in November, more milk will be produced than is needed in other months. The extra volume produced in these months constitutes seasonal reserves (table 3).

The volume of seasonal reserves is zero in November when milk production exactly supplies the need of fluid demand and operating reserves. The production of the exact milk volume to satisfy the requirements of fluid demand (5.2 million pounds a day) and operating reserves (0.52 million pounds a day) in November, generates a volume of seasonal reserves in other months that is defined as the balance between milk production by the same herds and fluid demand and operating

Table 3—Calculation of operating and seasonal reserves to satisfy fluid demand

Month	Seasonal index		Milk production	Fluid demand	Operating reserves	Seasonal reserves	Necessary reserves	
	Milk production	Fluid demand					Volume	Ratio to fluid demand
	------ Percent ------		*---------------- Million pounds per day --------------*					*Percent*
January	98	103	9.800	5.150	0.515	0.363	0.878	17.0
February	99	102	9.900	5.100	.510	.480	.990	19.4
March	104	101	10.400	5.050	.505	.841	1.346	26.7
April	108	98	10.800	4.900	.490	1.252	1.742	35.6
May	110	100	11.000	5.000	.500	1.266	1.766	35.3
June	109	97	10.900	4.850	.485	1.369	1.854	38.2
July	98	92	9.800	4.600	.460	.968	1.428	31.0
August	96	95	9.600	4.750	.475	.680	1.155	24.3
September	96	103	9.600	5.150	.515	.239	.754	14.6
October	94	103	9.400	5.150	.515	.117	.632	12.3
November	93	104	9.300	5.200	.520	0	.520	10.0
December	95	102	9.500	5.100	.510	.234	.744	14.6
Average	100	100	10.000	5.000	.500	.651	1.151	23.3

reserves. The volume of seasonal reserves is as high as 1.369 million pounds per day in June and as low as 0.117 million pounds a day in October. There are no seasonal reserves for November.

Total Necessary Reserves

The sum of operating reserve and seasonal reserve is the total necessary reserves. The total reserves are standby milk volume necessary to ensure sufficient supply for satisfying fluid demand year-round. This is the minimum volume of reserves that fluid handlers have to carry if they procure their own milk and balance their own supplies.

Necessary reserves range from 0.52 million pounds per day in November to 1.854 million pounds in June, with 1.151 million pounds being the daily average of the year (table 3). On a daily average basis, total necessary reserves are 23.3 percent of fluid demand. In other words, for every 100 pounds of fluid demand, it is necessary to carry an average of 23.3 pounds of milk reserves at a minimum to make sure that fluid demand will be satisfied year-round. Total necessary reserves in June are equivalent to 38.2 percent of the fluid demand for that month. In November, total necessary reserves required are 10 percent of the fluid demand.

Excess Reserves

Milk production in excess of both fluid demand and necessary reserves is defined as excess reserves and is used in manufacturing dairy products. The volume of excess reserves ranges from 3.58 million pounds in November to 4.234 million pounds per day in May (table 4).

Total Necessary and Excess Reserves

Total necessary and excess reserves are summarized in table 4. They peak in June at 6.05 million pounds a day. The lowest month is 4.1 million pounds a day in November. The relation between milk production, fluid demand, necessary reserves, and excess reserves is plotted in figure 1.

COSTS OF BALANCING NECESSARY RESERVES FOR FLUID MARKET

To dispose of the daily volume of 6.05 million pounds of milk in excess of fluid demand (necessary and excess reserves), two butter-powder plants, each with a daily capacity of 3.025 million pounds of milk, are required. This capacity allows the plants to operate 7 days a week (3 shifts, 20 machine-hours a day) and exhaust the available milk in June. The 6.05 million pounds per day volume in June is the highest combined total of necessary and excess reserves among the 12 months (table 4, column 4). For this study, milk volume is split equally between the two plants every day of the year. Each plant experiences the same seasonal fluctuation in reserve milk volume.

The variation of necessary reserves from month to month has a major impact on the undercapacity utilization of a butter-

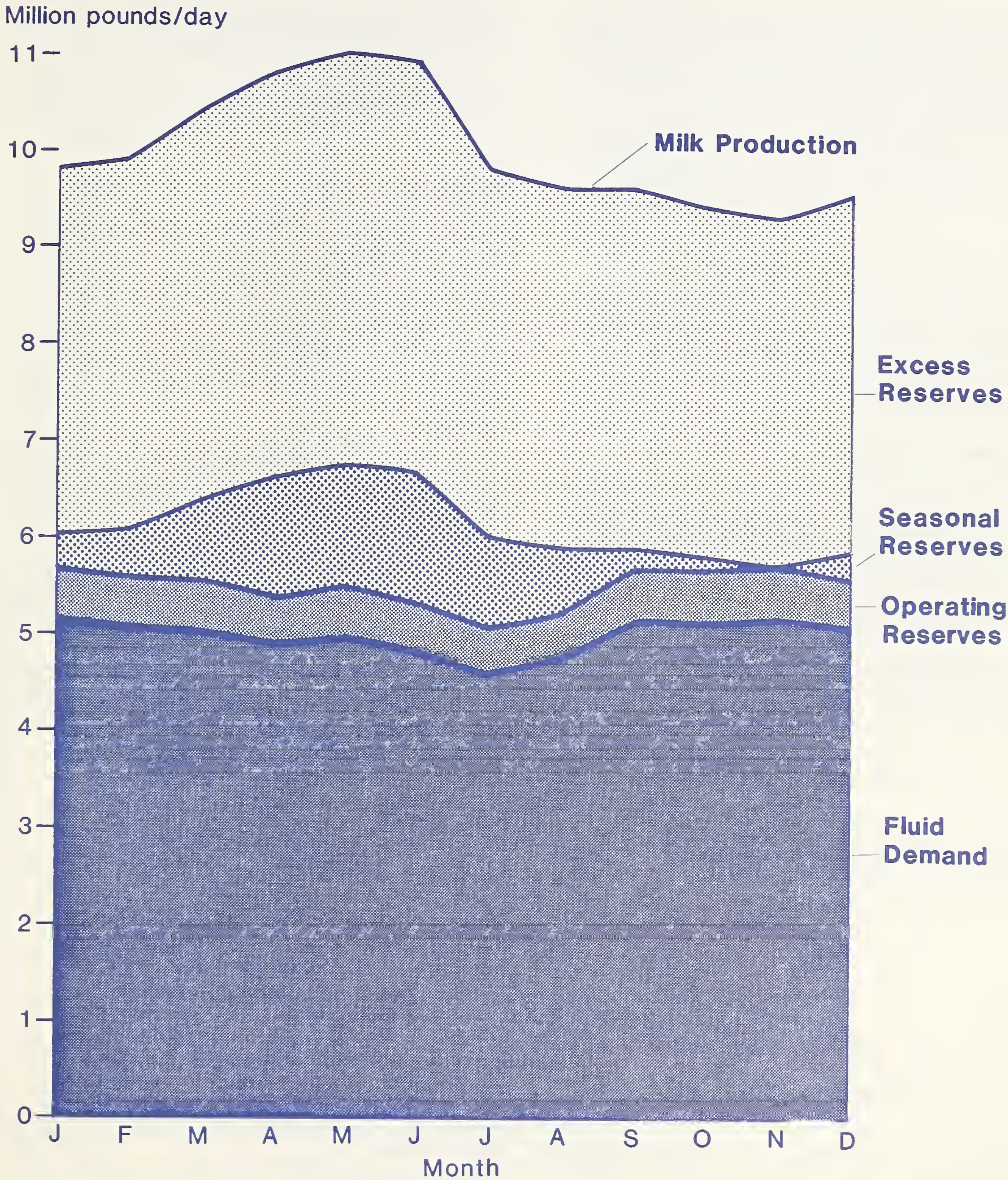
Table 4—Necessary and excess reserves for the fluid market

Month	Necessary reserves	Excess reserves	Necessary and excess reserves
	Million pounds per day		
January	0.878	3.772	4.650
February	.990	3.810	4.800
March	1.346	4.002	5.350
April	1.742	4.158	5.900
May	1.766	4.234	6.000
June	1.854	4.196	6.050
July	1.428	3.772	5.200
August	1.155	3.695	4.850
September	.754	3.696	4.450
October	.632	3.618	4.250
November	.520	3.580	4.100
December	.744	3.656	4.400
Average	1.151	3.849	5.000
	Hundred pounds of milk		
Yearly total	4,202,390	14,049,308	18,251,548

Table 5—Undercapacity caused by fluctuation in necessary reserves at a butter-powder plant with a daily capacity of manufacturing 3.025 million pounds of milk

Month	Undercapacity caused by necessary reserves	
	Million lbs./day	*Percent*
January	0.488	16.1
February	.432	14.3
March	.254	8.4
April	.056	1.9
May	.044	1.5
June	0	0
July	.213	7.0
August	.350	11.6
September	.550	18.2
October	.611	20.2
November	.667	22.1
December	.555	18.3
Average	.352	11.6
	Hundred pounds of milk	
Yearly total	1,282,510	

Figure 1 **The Relation Between Milk Production, Fluid Demand, and Reserves**



powder plant. Table 5 shows that January necessary reserves are 0.488 million pounds lower than the June peak reserves of 0.927 million pounds a day. The shortfall translates into a 16.1-percent underutilization of the plant's capacity. February shortfall was 0.432 million pounds a day, a 14.3-percent underutilization of plant capacity. The shortfalls for other months can be calculated the same way. The variation ranges from full-capacity operations in June to a shortfall of 0.667 million pounds a day in November, or a 22.1-percent underutilization. The yearly total shortfall is 128 million pounds.

The fluctuating volume of necessary reserves puts the reserve-balancing butter-powder plants at a disadvantage compared with a plant built solely for manufacturing. Milk volume going through the latter type of plant can be maintained constantly at capacity to take advantage of least-cost operations. Balancing necessary reserves, therefore, exacts a substantial cost on the two butter-powder plants.

Fixed and Overhead Costs[3]

A butter-powder plant with a capacity of manufacturing 3.025 million pounds of milk a day would cost $14.3 million (table 6). At 11 percent, annual total interest cost on land, building, machinery, and equipment is $1.6 million. Add to this the estimated overhead of taxes, licenses, insurance, and administrative cost, and total annual fixed and overhead costs are estimated at about $2.3 million.

The annual capacity of the butter-powder plant is 1,104 million pounds (3.025 million pounds for 365 days). The shortfall of 128 million pounds of milk because of fluctuating necessary fluid reserves represents 11.62-percent underutilization of annual capacity. The unused capacity amounts to $270,099 of annual fixed and overhead costs (11.62 percent of $2.3 million). This is the fixed portion of the annual costs of providing supply-balancing services for the fluid market by a butter-powder plant.

[3]In this report, fixed and overhead costs do not include depreciation incorporated in the inplant manufacturing costs shown later.

Table 6—Estimated annual fixed and overhead costs for a butter-powder plant with a daily capacity of manufacturing 3.025 million pounds of milk, assuming interest rate is 11 percent[1]

Item	Estimated present value	Annual cost
	Dollars	
Land	126,170	13,879
Building	5,046,800	555,148
Machinery and equipment	8,831,900	971,509
Automobile, fixtures, etc.	252,340	27,757
Taxes, licenses, insurance, and administration		757,020
Total annual fixed and overhead		2,325,313

[1]In this report, fixed and overhead costs do not include depreciation incorporated in the inplant manufacturing costs.

Table 7—Annual fixed and overhead costs of balancing necessary reserves for the fluid market

Month	Undercapacity caused by necessary reserves	Fixed and overhead costs
	Million pounds	*Dollars*
January	15.128	31,860
February	12.096	25,474
March	7.874	16,583
April	1.680	3,538
May	1.364	2,873
June	0	0
July	6.603	13,906
August	10.850	22,850
September	16.500	34,749
October	18.941	39,890
November	20.010	42,142
December	17.205	36,234
Total	128.251	270,099

Based on the shortfall volume, costs are allocated to each month in table 7. June is not allocated any fixed and overhead costs because it is a month of full-capacity operations. The other extreme is November, when it is allocated $42,142 of the fixed and overhead costs.

Plant Manufacturing Costs

Using the standard yield factors generally accepted by the industry, the plant capacity of 3.025 million pounds of milk at 3.67 percent butterfat test would require a butter-churning capacity of 135,520 pounds of butter a day and a powder-drying capacity of 245,933 pounds of nonfat dry milk a day. Assume that there is no shipment of intermediate product, cream or skim, into or out of the butter-powder plant. A 1-percent decrease in milk volume going through the butter-powder plant will correspondingly decrease capacity utilization of both the butter plant and the powder plant by 1 percent. In other words, the fluctuating volume of necessary reserves affects underutilization of the butter plant and the powder plant by the same percentage. Undercapacity percentages reported in table 5 apply equally to both the butter plant and the powder plant.

Based on available data, increases in the costs of manufacturing butter and powder due to undercapacity caused

by necessary reserves can be calculated. The calculation uses the selected cost curves estimated and reported in ACS research report No. 34 for butter and powder plants. The scales of the selected plants are, respectively, closest to manufacturing 135,520 pounds of butter and 245,933 pounds of nonfat dry milk a day.

Manufacturing costs are limited to inplant costs from the milk receiving deck to the product delivery deck. These costs are directly associated with manufacturing operations of the plant. They include labor (direct labor, supervisory/indirect labor, and fringe benefits), electricity, fuel, water and sewage, plant and cleaning supplies, repair and maintenance, depreciation, taxes and insurance (incidental to the manufacturing operations), and miscellaneous expenses. Except for depreciation, these cost items are generally described as variable costs. Some of them may be semivariable or semifixed.

Table 8 lists increases in the inplant costs of manufacturing butter and powder caused by the fluctuating volume of necessary reserves for the 12 months. June is operated at full capacity and the manufacturing costs are the lowest. When the plant is operating at less than capacity, manufacturing costs increase by 0.5135 cent per pound of butter in January, by 0.4509 cent in February, and so on. Increase in the costs of manufacturing powder is by 0.1098 cent per pound in January, by 0.0842 cent in February, and so forth. By using standard yield factors, the above increases in manufacturing costs can be converted to a per hundredweight of milk basis. Column 5 of table 8 shows that increases in manufacturing costs due to undercapacity caused by necessary reserves range from 0.04 cent per hundredweight of milk manufactured in May to 4.27 cents per hundredweight in November. Expanding these extra costs by the total volume of necessary and excess reserves, monthly total increase in the manufacturing costs due to reserve balancing is zero in June and ranges from $256 in May to $30,280 in October (column 6, table 8). Total extra manufacturing cost for the entire year is $195,168.

Total Costs of Balancing Necessary Reserves

Fixed and overhead costs and the increases in costs of plant manufacturing operations incurred by a butter-powder plant discussed above are combined to constitute total reserve-balancing costs (table 9). For maintaining necessary reserves for the fluid market, a butter-powder plant with a capacity of 3.025 million pounds has a total supply-balancing cost ranging from $3,129 in May to $72,363 in November. There is no balancing cost in June, the month of full-capacity operations.

Because the market needs two such plants to balance the necessary reserves, total balancing costs for the market are doubled (table 10). The supply-balancing cost is as low as 0.4 cent per hundredweight of fluid sales in May and as high as 9.3 cents per hundredweight of fluid milk in November. On a per hundredweight of necessary reserve basis, the cost ranges from 1.1 cents to 92.8 cents for these same 2 months.

Table 8—Increases in plant manufacturing costs due to undercapacity caused by necessary reserves, incurred by a butter-powder plant with a daily capacity of manufacturing 3.025 million pounds of milk

Month	Undercapacity caused by necessary reserves	Increases in plant manufacturing costs due to undercapacity			
		Butter	Powder	Milk[1]	Monthly total
	Percent	*---Cents/lbs.---*		*Cents/cwt.*	*Dollars*
January	16.1	0.5135	0.1098	3.19	25,119
February	14.3	.4509	.0842	2.70	19,571
March	8.4	.2046	.0272	1.14	9,817
April	1.9	.0122	.0012	.06	561
May	1.5	.0076	.0008	.04	256
June	0	0	0	0	0
July	7.0	.1511	.0189	.83	7,258
August	11.6	.3397	.0535	1.96	16,298
September	18.2	.5613	.1430	3.67	27,318
October	20.2	.5765	.1809	4.05	30,280
November	22.1	[2].5535	.2208	4.27	30,221
December	18.3	.5638	.1459	3.72	28,469
Yearly total					195,168

[1]Yield factors per hundredweight of milk at 3.67 percent butterfat test: 4.48 pounds of butter and 8.13 pounds of nonfat dry milk.
[2]This estimate may be biased because 22.1 percent below capacity is outside the range of the cost curve used.

Table 9—Total costs of balancing necessary reserves for the fluid market, incurred by a butter-powder plant with a daily capacity of manufacturing 3.025 million pounds of milk

Month	Fixed and overhead costs	Inplant manufacturing costs	Total reserve-balancing costs
		Dollars	
January	31,860	25,119	56,979
February	25,474	19,571	45,045
March	16,583	9,817	26,400
April	3,538	561	4,099
May	2,873	256	3,129
June	0	0	0
July	13,906	7,258	21,164
August	22,850	16,298	39,148
September	34,749	27,318	62,067
October	39,890	30,280	70,170
November	42,142	30,221	72,363
December	36,234	28,469	64,703
Total	270,099	195,168	465,267

COMPENSATING DAIRY COOPERATIVES FOR SUPPLY-BALANCING SERVICES

Assume that milk in the market is supplied by three dairy cooperatives, each with its own set of similar but different seasonality of milk production and fluid sales (tables 11-13). On a daily average basis, cooperative No. 1 handles 5 million pounds of milk for its members, 36 percent of which is sold for fluid uses (table 11). Fluid sales is 60 percent of cooperative No. 2 members' 3 million pounds daily average production. Milk volume is less, at 2 million pounds, for cooperative No. 3, while its fluid utilization is at a higher, 70 percent rate. Milk volumes in excess of fluid uses average 3.2 million, 1.2 million, and 0.6 million pounds per day for the three cooperatives, respectively.

Producers supplying the market are paid on the basis of the price determined by a marketwide producer pool. Handlers pay into the pool based on their uses of milk. They pay a fluid differential for milk used in fluid products.

Paying Cooperatives for the Reserve-Balancing Costs

For each month, necessary reserves are allocated to the three cooperatives based on their respective shares of market fluid

Table 10—Total costs of balancing necessary reserves for the fluid market

Month	Necessary reserves	Fluid demand	Reserve-balancing costs	Costs per hundredweight of: Necessary reserves	Costs per hundredweight of: Fluid demand
	---Million pounds---		*Dollars*	------*Cents*-----	
January	27.218	159.650	113,958	41.9	7.1
February	27.720	142.800	90,090	32.5	6.3
March	41.726	156.550	52,800	12.7	3.4
April	52.260	147.000	8,198	1.6	.6
May	54.746	155.000	6,258	1.1	.4
June	55.620	145.500	0	0	0
July	44.268	142.600	42,328	9.6	3.0
August	35.805	147.250	78,296	21.9	5.3
September	22.620	154.500	124,134	54.9	8.0
October	19.592	159.650	140,340	71.6	8.8
November	15.600	156.000	144,726	92.8	9.3
December	23.064	158.100	129,406	56.1	8.2
Total	420.239	1,824.600	930,534	[1]22.1	[1]5.1

[1]Weighted average.

Table 11—Milk production, fluid sales, and milk in excess of fluid uses, cooperative No. 1

Month	Seasonal index: Milk production	Seasonal index: Fluid demand	Milk production	Fluid sales	Milk in excess of fluid uses
	------ *Percent* ------		------- *Million pounds per day* ------		
January	98	101	4.900	1.826	3.074
February	98	100	4.920	1.804	3.116
March	107	98	5.330	1.772	3.558
April	112	91	5.600	1.636	3.964
May	113	105	5.660	1.882	3.778
June	116	102	5.780	1.828	3.952
July	99	90	4.930	1.620	3.310
August	93	100	4.670	1.806	2.864
September	94	102	4.700	1.836	2.864
October	91	101	4.540	1.822	2.718
November	89	109	4.460	1.968	2.492
December	90	100	4.510	1.800	2.710
Average	100	100	5.000	1.800	3.200

Table 12—Milk production, fluid sales, and milk in excess of fluid uses, cooperative No. 2

Month	Seasonal index: Milk production	Seasonal index: Fluid demand	Milk production	Fluid sales	Milk in excess of fluid uses
	------ *Percent* ------		------- *Million pounds per day* ------		
January	98	103	2.940	1.854	1.086
February	100	103	3.000	1.854	1.146
March	101	102	3.030	1.836	1.194
April	104	102	3.120	1.836	1.284
May	106	97	3.180	1.746	1.434
June	100	94	3.000	1.692	1.308
July	97	94	2.910	1.692	1.218
August	99	92	2.970	1.656	1.314
September	98	104	2.940	1.872	1.068
October	98	104	2.940	1.872	1.068
November	98	101	2.940	1.818	1.122
December	101	104	3.030	1.872	1.158
Average	100	100	3.000	1.800	1.200

Table 13—Milk production, fluid sales, and milk in excess of fluid uses, cooperative No. 3

Month	Seasonal index: Milk production	Seasonal index: Fluid demand	Milk production	Fluid sales	Milk in excess of fluid uses
	------ Percent ------		------- Million pounds per day ------		
January	98	105	1.960	1.470	0.490
February	99	103	1.980	1.442	.538
March	102	103	2.040	1.442	.598
April	104	102	2.080	1.428	.652
May	108	98	2.160	1.372	.788
June	106	95	2.120	1.330	.790
July	98	92	1.960	1.288	.672
August	98	92	1.960	1.288	.672
September	98	103	1.960	1.442	.518
October	96	104	1.920	1.456	.464
November	95	101	1.900	1.414	.486
December	98	102	1.960	1.428	.532
Average	100	100	2.000	1.400	.600

Table 14—Allocation of necessary reserves to the three cooperatives based on fluid sales

Month	Market	Cooperative No. 1	Cooperative No. 2	Cooperative No. 3
		Million pounds		
January	27.218	9.641	9.796	7.781
February	27.720	9.800	10.080	7.840
March	41.726	14.632	15.190	11.904
April	52.260	17.430	19.590	15.240
May	54.746	20.615	19.127	15.004
June	55.620	20.970	19.410	15.240
July	44.268	15.593	16.275	12.400
August	35.805	13.609	12.493	9.703
September	22.620	8.070	8.220	6.330
October	19.592	6.913	7.130	5.549
November	15.600	5.910	5.460	4.230
December	23.064	8.153	8.463	6.448
Total	420.239	151.336	151.234	117.669

sales (table 14). If each of the three possesses manufacturing plant(s) with enough capacity to handle its own pooled producer milk in excess of fluid uses, paying cooperatives for reserve-balancing services can be handled in the following straightforward manner. For each hundredweight of milk used in fluid products, an assessment based on the rate shown in table 10 may be made on fluid milk and deducted from the marketwide pool before the pool is calculated. Payments to dairy cooperatives are based on their respective shares of the market necessary reserves.

Deductions and payments are summarized in table 15. In January, the balancing cost deduction from the pool is 7.1 cents per hundredweight of fluid demand, or a total of $113,958. In February, the deduction is 6.3 cents per hundredweight, or a total of $90,090. Deductions for other months are shown down the column. Total deductions for the year are $930,534, or a weighted average of 5.1 cents per hundredweight of fluid milk sold in the year.

Payment to dairy cooperatives in January is at a rate of 41.9 cents per hundredweight of necessary reserves balanced by the cooperatives; in February, it is 32.5 cents; and so forth. The yearly weighted average is 22.1 cents per hundredweight of necessary reserves. Payments to cooperatives No. 1 and No. 2 are both about $335,000 for the year. Cooperative No. 3 is paid about $260,000.

A Reserve-Balancing Pool

The above payment system can be viewed as a reserve-balancing pool to deduct reserve-balancing credits from the marketwide producer pool and pay cooperatives for the costs of maintaining necessary reserves for the fluid market. A reserve-balancing pool is very useful in facilitating payment distribution in complicated cases where there are intercooperative shipments of milk, where some cooperatives do not own manufacturing plants, and where there are "independent" producers who are not cooperative members but are affiliated with fluid handlers without reserve-balancing facilities.

To help explain operations of the reserve-balancing pool, suppose cooperative No. 3 is a bargaining cooperative. It bargains for its members with fluid handlers over price and other terms of trade, but owns no reserve-balancing plant facilities. Milk in excess of fluid sales is shipped to cooperatives No. 1 and No. 2 for manufacturing. Cooperative No. 3 is similar in this case to a collection of all independent producers who deliver milk to fluid handlers and utilize plants owned by cooperatives No. 1 and No. 2 for reserve balancing.

For the particular market in this study, supply-balancing costs are very low during April, May, and June (table 15). These 3 months can be used as the reserve-balancing pool formation

Table 15—Calculating payments to cooperatives for supply-balancing services

Month	Balancing cost deduction per unit of fluid milk	Total balancing cost deduction from the market-wide producer pool	Payments for balancing services: Cooperative No. 1	Cooperative No. 2	Cooperative No. 3	Payment per unit of necessary reserves
	Cents/cwt.	*Dollars*				*Cents/cwt.*
January	7.1	113,958	40,366	41,014	32,578	41.9
February	6.3	90,090	31,850	32,760	25,480	32.5
March	3.4	52,800	18,515	19,222	15,063	12.7
April	.6	8,198	2,734	3,073	2,391	1.6
May	.4	6,258	2,357	2,186	1,715	1.1
June	0	0	0	0	0	0
July	3.0	42,328	14,910	15,562	11,856	9.6
August	5.3	78,296	29,759	27,319	21,218	21.9
September	8.0	124,134	44,286	45,110	34,738	54.9
October	8.8	140,340	49,519	51,073	39,748	71.6
November	9.3	144,726	54,829	50,654	39,243	92.8
December	8.2	129,406	45,744	47,484	36,178	56.1
Total	[1]5.1	930,534	334,869	335,457	260,208	[1]22.1

[1]Weighted average.

period. During this time period, dairy cooperatives establish their respective claims to the reserve-balancing pool. Credits are paid to the cooperatives based on established claims during the subsequent 9-month reserve-balancing pool payment period, July through the following March. The pool operates in a 12-month cycle: 3 months for pool formation and 9 months for pool payment. A new cycle will start in April.

Two basic scenarios will help illustrate how the reserve-balancing pool works.

Scenario 1

Assume that during the months of April, May, and June, cooperative No. 3 (or independent producers as a group) shipped 80, 70, and 60 percent of its pooled producer milk in excess of fluid uses to cooperative No. 1 for manufacturing. The remaining 20, 30, and 40 percent, respectively, was shipped to cooperative No. 2 during the same months (table 16). As a result, cooperative No. 1 manufactures 401.6 million pounds of milk in its plant(s) during the 3-month period, 47 million pounds more than its pooled producer milk in excess of fluid uses. This indicates that cooperative No. 1 does manufacture in its plant(s) its own share of necessary reserves, which is allocated to the cooperative based on fluid sales. Therefore, cooperative No. 1 is entitled to 100 percent of its share of necessary reserves. By the same token, cooperative No. 2 manufactures 20.7 million pounds more than its pooled producer milk in excess of fluid uses, and is entitled to 100 percent of its own share of necessary reserves.

Cooperative No. 3 (or independent producers as a group) does not own manufacturing facilities, and transfers all its pooled producer milk in excess of fluid uses during the reserve-balancing pool formation period, or 67.7 million pounds, to other cooperatives. Thus, it is not entitled to any of its share of necessary reserves, but transfers the share to the reserve-balancing pool to be distributed to other cooperatives that actually take on the reserve-balancing responsibility.

Cooperative No. 1 received 47 million pounds (or 69.4 percent) of the 67.7 million pounds of pooled producer milk in excess of fluid uses transferred by cooperative No. 3. It is therefore entitled to 69.4 percent of the remaining reserve-balancing pool not otherwise claimed by cooperatives No. 1 or No. 2. In the present case, it is 69.4 percent of cooperative No. 3's share of necessary reserves. The remaining 30.6 percent is similarly distributed to cooperative No. 2 for the 20.7 million pounds of cooperative No. 3's pooled producer milk in excess of fluid uses it receives and manufactures.

Table 16—Calculation of claims on reserve-balancing pool based on shipments of pooled producer milk in excess of fluid uses during the pool formation period — Scenario One

Month or item	Pooled producer milk in excess of fluid sales								
	Cooperative No. 1			Cooperative No. 2			Cooperative No. 3 (or independent producers as a group)		
	Manufactured	Pooled	Net shipments (-) or net receipts	Manufactured	Pooled	Net shipments (-) or net receipts	Manufactured	Pooled	Net shipments (-) or net receipts
	Million pounds								
April	134.580	118.920	15.660	42.420	38.520	3.900	0	19.560	-19.560
May	134.230	117.118	17.112	51.770	44.454	7.316	0	24.428	-24.428
June	132.780	118.560	14.220	48.720	39.240	9.480	0	23.700	-23.700
Total	401.590	354.598	46.992	142.910	122.214	20.696	0	67.688	-67.688
	Percent								
Claim on own share of necessary reserves[1]		100.0			100.0			0	
Own share of necessary reserves ceded to the reserve-balancing pool		0			0			100.0	
Claim on the remaining reserve-balancing pool not otherwise claimed (percent of total net shipments)			69.4			30.6			0

[1]It is 100 percent if pooled milk manufactured at the cooperative's plant(s) is more than milk in excess of fluid uses pooled by the cooperative.

Claims on the reserve-balancing pool established during the pool formation period of April through June are then applied during the reserve-balancing pool payment period of July through the following March.

Table 17 shows that in July the market requires 44.268 million pounds of necessary reserves which constitute the total volume of the reserve-balancing pool for the month. Based on the three cooperatives' July deliveries of pooled milk for fluid uses, the necessary reserves are allocated to the three cooperatives. Because it has been established during the pool formation period that cooperatives No. 1 and No. 2 are entitled to 100 percent of their own respective shares of necessary reserves, 15.593 million pounds are credited to cooperative No. 1 and 16.275 million pounds to cooperative No. 2. The remaining 12.4 million pounds in the pool are the share of necessary reserves attributed to cooperative No. 3's fluid sales. However, they are credited to cooperatives No. 1 and No. 2 for their roles in balancing the reserves, 69.4 percent or 8.606 million pounds to cooperative No. 1, and 30.6 percent or 3.794 million pounds to cooperative No. 2.

Total volume of necessary reserves credited to cooperative No. 1 for the month of July is 24.199 million pounds. For cooperative No. 2, it is 20.069 million pounds. At 9.6 cents per hundredweight, the two cooperatives should receive from the pool the reserve-balancing credits of $23,139 and $19,189, respectively, if they are paid for their supply-balancing services. For the other 8 pool payment months, the reserve-balancing pool credits can be calculated in the same manner.

Scenario Two

During the reserve-balancing pool formation months of April, May, and June, assume that cooperative No. 1 receives the same 80, 70, and 60 percent, respectively, of cooperative No. 3's pooled milk in excess of fluid uses as in scenario 1 and cooperative No. 2 receives the same 20, 30, and 60 percent. However, due to the limitation of its plant capacity, cooperative No. 2 also ships out milk to maintain the volume at the plant at around 38.5 million pounds a month (table 18). It ships 10 percent of its pooled producer milk in excess of fluid uses to cooperative No. 1 in April, 30 percent in May,

Table 17—Distribution of necessary reserves to cooperatives based on shipments of pooled producer milk in excess of fluid uses during the pool formation period — Scenario One

Item	July	August	September	October	November	December	January	February	March	Total
					Million pounds					
Necessary reserves credited to:										
Market (reserve-balancing pool)	44.268	35.805	22.620	19.592	15.600	23.064	27.218	27.720	41.726	257.613
Cooperative No. 1, 100 percent own share	15.593	13.609	8.070	6.913	5.910	8.153	9.641	9.800	14.632	92.321
Cooperative No. 2, 100 percent own share	16.275	12.493	8.220	7.130	5.460	8.463	9.796	10.080	15.190	93.107
Remaining reserve-balancing pool not otherwise claimed:										
Ceded by Cooperative No. 3 (or independent producers as a group)	12.400	9.703	6.330	5.549	4.230	6.448	7.781	7.840	11.904	72.185
69.4 percent credited to cooperative No. 1	8.606	6.734	4.393	3.851	2.936	4.475	5.400	5.441	8.261	50.097
30.6 percent credited to cooperative No. 2	3.794	2.969	1.937	1.698	1.294	1.973	2.381	2.399	3.643	22.088
Total volume of necessary reserves credited to:										
Cooperative No. 1	24.199	20.343	12.463	10.764	8.846	12.628	15.041	15.241	22.893	142.418
Cooperative No. 2	20.069	15.462	10.157	8.828	6.754	10.436	12.177	12.479	18.833	115.195
						Dollars				
Reserve-balancing credit to:										
Cooperative No. 1	23,139	44,485	68,394	77,104	82,067	70,852	62,975	49,533	28,969	507,518
Cooperative No. 2	19,189	33,811	55,740	63,236	62,659	58,554	50,983	40,557	23,831	408,560

and 25 percent in June. As a result, cooperative No. 2 manufactures 0.048 million pounds more milk than its pooled producer milk in excess of fluid uses in April. It manufactures 6.02 million pounds less than pooled producer milk in excess of fluid uses in May and 0.33 million pounds less in June. Over the entire reserve-balancing pool formation period, cooperative No. 2 manufactures 6.302 million pounds less milk than its pooled producer milk in excess of fluid uses. Cooperative No. 2 manufactures a milk volume 94.8 percent of its pooled producer milk in excess of fluid uses. By proration, it is entitled to 94.8 percent of its own share of necessary reserves, and transfers the other 5.2 percent to the remaining reserve-balancing pool.

Cooperative No. 1 manufactures 73.99 million pounds more milk than its pooled producer milk in excess of fluid uses during the 3 reserve-balancing pool formation months, the total net volume shipped by cooperative No. 2 and No. 3. It is entitled to 100 percent of its own share of necessary reserves. In addition, it has a claim on all the necessary reserves in the remaining reserve-balancing pool not otherwise claimed.

The claims by the three cooperatives on the reserve-balancing pool established during the pool formation period are applied during the pool payment period July through the following March. Table 19 shows that the necessary reserves required by the market in July are 44.268 million pounds, the same total volume of the reserve-balancing pool as in scenario 1. Because cooperative No. 1 is entitled to 100 percent of its own share of necessary reserves, it is credited with the full 15.593 million pounds. However, cooperative No. 2 is only entitled to 94.8 percent of its own share of necessary reserves under this scenario. It is therefore credited with 15.429 million pounds of necessary reserves for the month. The other 0.846 million pounds of necessary reserves attributed to cooperative No. 2 and 12.4 million pounds attributed to cooperative No. 3, based on their fluid sales, are credited to cooperative No. 1.

The volume of market necessary reserves credited to cooperative No. 1 is 28.839 million pounds for July. At 9.6 cents per hundredweight, the reserve-balancing pool credit to cooperative No. 1 is $27,575. The reserve-balancing pool credit to cooperative No. 2 for the 15.429 million pounds of necessary reserves is $14,753. The same pool credit calculating method applies to the other 8 pool payment months.

During the reserve-balancing pool formation period, a cooperative's own share of necessary reserves based on its fluid sales (before any proration under scenarios 1 and 2 is

Table 18—Calculation of claims on reserve-balancing pool based on shipments of pooled producer milk in excess of fluid uses during the pool formation period — Scenario Two

Month or item	Pooled producer milk in excess of fluid sales								
	Cooperative No. 1			Cooperative No. 2			Cooperative No. 3 (or independent producers as a group)		
	Manufactured	Pooled	Net shipments (-) or net receipts	Manufactured	Pooled	Net shipments (-) or net receipts	Manufactured	Pooled	Net shipments (-) or net receipts
					Million pounds				
April	138.432	118.920	19.512	38.568	38.520	0.048	0	19.560	-19.560
May	147.566	117.118	30.448	38.434	44.454	-6.020	0	24.428	-24.428
June	142.590	118.560	24.030	38.910	39.240	-0.330	0	23.700	-23.700
Total	428.588	354.598	73.990	115.912	122.214	-6.302	0	67.688	-67.688
					Percent				
Claim on own share of necessary reserves[1]		100.0			94.8			0	
Own share of necessary reserves ceded to the reserve-balancing pool		0			5.2			100.0	
Claim on the remaining reserve-balancing pool not otherwise claimed (percent of total net shipments)			100.0			0			0

[1]It is 100 percent if pooled milk manufactured at the cooperative's plant(s) is more than milk in excess of fluid uses pooled by the cooperative.

done) might be more than the cooperative's pooled producer milk in excess of fluid uses. In this case, its share of necessary reserves should be reduced to equal the volume of its pooled producer milk in excess of fluid uses. The remaining necessary reserves should be prorated to the other cooperatives based on their respective volumes of necessary reserves.

If the volume of necessary reserves for the market is higher than the combined total of all cooperatives' pooled producer milk in excess of fluid uses during the reserve-balancing pool formation period, it would mean that the volume of reserves balanced by the cooperatives is less than that required by the market.[4] Then the total size of the reserve-balancing pool in each of the 9 months during the subsequent pool payment period should be proportionately reduced to reflect the fact that not enough reserves are maintained by the cooperatives that are qualified to receive the pool credits. Accordingly, reserve-balancing pool credits to each cooperative should also be proportionately reduced.

[4]The remaining volume of necessary reserves may be balanced by plants in other nearby markets. In this case, the definition of a market may be broadened to incorporate all markets involved. However, this should not include the case where fluid milk deficit or a surge in fluid milk demand is satisfied by purchases from a distant market on a spot, as needed basis.

For example, under scenario 1 in table 16, if the volume of necessary reserves attributed to cooperative No. 2 is higher than the 122.214 million pounds of pooled producer milk in excess of fluid uses, the cooperative's own share of necessary reserves should be reduced to be the same as its pooled producer milk in excess of fluid uses. The difference between the volume of necessary reserves originally calculated and the new, reduced volume should be distributed to cooperatives No. 1 and No. 3 based on their shares of necessary reserves. Therefore, cooperative No. 2's claim on 100 percent of its own share of necessary reserves is 100 percent of a lesser volume. The fact that cooperative No. 2 manufactures more milk than its pooled producer milk in excess of fluid uses only establishes its claim on the remaining reserve-balancing pool not otherwise claimed.

Table 19—Distribution of necessary reserves to cooperatives based on shipments of pooled producer milk in excess of fluid uses during the pooi formation period — Scenario Two

Item	July	August	September	October	November	December	January	February	March	Total
					Million pounds					
Necessary reserves credited to:										
Market (reserve-balancing pool)	44.268	35.805	22.620	19.592	15.600	23.064	27.218	27.720	41.726	257.613
Cooperative No. 1, 100 percent own share	15.593	13.609	8.070	6.913	5.910	8.153	9.641	9.800	14.632	92.321
Cooperative No. 2, 94.8 percent own share	15.429	11.843	7.793	6.759	5.176	8.023	9.287	9.556	14.400	88.266
Remaining reserve-balancing pool not otherwise claimed:										
Ceded by Cooperative No. 2	0.846	0.650	0.427	0.371	0.284	0.440	0.509	0.524	0.790	4.841
Ceded by Cooperative No. 3 (or independent producers as a group)	12.400	9.703	6.330	5.549	4.230	6.448	7.781	7.840	11.904	72.185
100 percent credited to cooperative No. 1	13.246	10.353	6.737	5.920	4.514	6.888	8.290	8.364	12.694	77.026
Total volume of necessary reserves credited to:										
Cooperative No. 1	28.839	23.962	14.827	12.833	10.424	15.041	17.931	18.164	27.326	169.347
Cooperative No. 2	15.429	11.843	7.793	6.759	5.176	8.023	9.287	9.556	14.400	88.266
					Dollars					
Reserve-balancing credit to:										
Cooperative No. 1	27,575	52,399	81,368	91,924	96,707	84,391	75,075	59,033	34,578	603,049
Cooperative No. 2	14,753	25,897	42,766	48,416	48,019	45,015	38,883	31,057	18,222	313,029

On the other hand, cooperative No. 1's claims on 100 percent of its own share of necessary reserves and 69.4 percent of the remaining reserve-balancing pool not otherwise claimed are 100 percent and 69.4 percent, respectively, of a larger volume.

If the combined total of the pooled producer milk in excess of fluid uses, or 544.5 (354.598 + 122.214 + 67.688) million pounds, is, for example, 10 percent less than the volume of necessary reserves attributed to the three cooperatives during the pool formation period, then every number in table 17 would have to be reduced by 10 percent.

If the same situations arise under scenario 2, the same adjustments should be made in tables 18 and 19.

To receive the full reserve-balancing pool credit, a cooperative must continue to own manufacturing facilities with a total capacity no less than the cooperative's total claim on the necessary reserves for a pool payment month, except for temporary shutdowns for repair and maintenance.

Summary

This report proposes a reserve-balancing pool to deal with the issue of compensating dairy cooperatives for supply-balancing services they provide for the fluid market at their plants. The procedures include three major elements: (1) determining the volume of necessary reserves to be maintained for servicing the fluid market, (2) determining the costs of balancing necessary reserves which fluctuate from month to month, and (3) calculating the value of the reserve-balancing pool so it can be deducted from the marketwide producer pool and equitably credited to dairy cooperatives for performing the supply-balancing services. The procedures are summarized in the following table.

Reserve-balancing pool procedures	Example in this report
I. Determine necessary reserves for the fluid market	
• Calculate indices of seasonality of milk production and fluid demand.	• Table 1.
• Decide on operating reserves for the fluid market.	• Ten percent of fluid demand
• Determine seasonal reserves resulting from satisfying fluid demand and maintaining operating reserves.	• Table 3
• Sum up operating and seasonal reserves to constitute necessary reserves for the fluid market.	• Table 3
• Express the volume of necessary reserves as a percent of fluid demand.	• Table 3
II. Determine the costs of balancing necessary reserves	
• Milk production in excess of fluid demand and necessary reserves is excess reserves.	• Tables 3 and 4
• Sum necessary and excess reserves. Identify the month with the highest volume of necessary and excess reserves.	• Table 4, the month of June, 6.05 million pounds per day
• Determine the optimal scale of manufacturing plant and number of plants to exhaust this volume.	• Two plants, each with a capacity of manufacturing 3.025 million pounds a day
• For each month, calculate the volume of necessary reserves below the peak necessary reserves.	• Table 5
• For each month, express the volume so calculated as a percent of the highest volume of necessary and excess reserves—it is the unused plant capacity caused by the fluctuation in necessary reserves.	• Table 5
• Determine the fixed and overhead costs associated with unused capacity.	• Tables 6 and 7
• Determine increases in plant costs as a result of manufacturing below-capacity volume.	• Table 8
• The sum of the fixed and overhead costs and increases in plant manufacturing costs is the total reserve-balancing costs.	• Table 9
• Express reserve-balancing costs in cents per hundredweight of fluid demand and per hundredweight of necessary reserves.	• Table 10

Reserve-balancing pool procedures	Example in this report
III. Reserve-balancing pool calculation	
• Based on the percentages in table 3, and market fluid demand and bulk fluid sales by each cooperative, calculate the volume of necessary reserves for the market and the share of each cooperative. The volume of market necessary reserves is the size of reserve-balancing pool.	• Table 14
• Select the period with the highest volume of necessary reserves to be the reserve-balancing pool formation period.	• April, May, and June
• During the pool formation period, if a cooperative's share of necessary reserves is higher than its pooled producer milk in excess of fluid uses, its share of necessary reserves is reduced to equal the latter. The difference is prorated to other cooperatives based on the share of necessary reserves.	• (This may occur to a cooperative with high fluid utilization)
• During the pool formation period, if the volume of necessary reserves required by the market is higher than the total of all pooled producer milk in excess of fluid uses, the former is reduced to equal the latter. Each cooperative's share of necessary reserves should be proportionately reduced. So is the size of the reserve-balancing pool during the subsequent pool payment period.	• (This may occur in a milk deficit market)
• During the pool formation period, if the volume of pooled milk manufactured by a cooperative is higher than its pooled producer milk in excess of fluid uses, it is entitled to 100 percent of its share of necessary reserves calculated up to this point.	• Tables 16 and 18
• During the pool formation period, if the volume of pooled milk manufactured by a cooperative is lower than its pooled producer milk in excess of fluid uses, it is entitled to a portion of its share of necessary reserves calculated up to this point, the portion being the ratio of the volume manufactured to the volume of pooled producer milk in excess of fluid uses. The remaining portion is ceded to the reserve-balancing pool.	• Tables 16 and 18
• The remaining reserve-balancing pool not otherwise claimed is credited to a cooperative, based on its share of net receipts of intercooperative shipments of pooled producer milk in excess of fluid uses.	• Tables 16 and 18
• Select the reserve-balancing pool payment period. The pool formation and payment periods should run a yearly cycle.	• July through March
• For each pool payment month, determine the size of the reserve-balancing pool. Use reserve-balancing costs in table 10 to calculate the pool value. The value of the reserve-balancing pool should be deducted from the marketwide producer pool.	• Tables 17 and 19
• Credit each cooperative according to its share of the reserve-balancing pool established above during the pool formation period. The paying rate is in table 10.	• Tables 17 and 19
• To receive the full reserve-balancing pool credit, a cooperative must continue to own manufacturing facilities with a total capacity no less than the cooperative's total claim of necessary reserves for a pool payment month, except for temporary shutdowns for repair and maintenance.	

Alternative Procedure for the Reserve-Balancing Pool Calculation

An alternative method for allocating necessary reserves to the three cooperatives is to base the allocation on each cooperative's share in the marketwide producer pool. In other words, the volume of necessary reserves is prorated on the milk volume each cooperative delivers to the market for fluid and other uses. The rationale is that the larger a volume handled by a cooperative, the larger a base from which milk can be drawn to satisfy fluid demand when extra deliveries are required.

This alternative allocating procedure is particularly useful in the more general and complicated case where each fluid handler may receive milk from more than one supplier and each supplier may deliver milk to more than one handler. Milk is commingled and loses its identity when it is pumped into the storage silo at a plant. It is impractical to trace every pound of milk to its final uses. Therefore, each cooperative's fluid sales (and its pooled milk in excess of fluid uses) cannot be accurately determined. Proration on a marketwide basis becomes necessary.

Allocation of the volume of necessary reserves to the three cooperatives based on the cooperatives' respective market shares in the marketwide producer pool is shown in table 20. Compared with the allocation in table 14, the present proration favors cooperative No. 1 because of its relatively large total milk volume. If each cooperative has the plant capacity to manufacture its own share of necessary reserves, payments for supply-balancing services are shown in table 21 (compare table 21 with table 14).

In the case where one or more cooperatives do not manufacture part or all of their respective shares of necessary reserves, the reserve-balancing pool can be used to reallocate the claims on the volume of necessary reserves.

Assume that both cooperatives No. 1 and No. 2 manufacture more milk than their respective shares of necessary reserves during the pool formation period of April, May, and June. Cooperative No. 3 does not own manufacturing facilities so its share of necessary reserves is ceded to the reserve-balancing pool to be redistributed to the other two cooperatives (table 22).

During the pool payment period of July through March, cooperatives No. 1 and No. 2 both have a 100-percent claim on their respective shares of necessary reserves allocated to them based on their shares of the marketwide producer pool. In addition, they also have claims over the volume of necessary reserves ceded by cooperative No. 3 to the reserve-balancing pool, allocated to them on the same market share basis.

The reserve-balancing pool calculation is shown in table 23. In July, the volume of necessary reserves required by the fluid market is 44.268 million pounds. This volume is allocated to the three cooperatives based on their July market shares: 22.288 million pounds to cooperative No. 1, 13.136 million pounds to cooperative No. 2, and 8.844 million pounds to cooperative No. 3. Because it has been established during the pool formation period that cooperatives No. 1 and No. 2 are entitled to 100 percent of their respective shares of necessary reserves, they will keep the volumes allocated in full. Furthermore, they are allocated the 8.844 million pounds ceded by cooperative No. 3, again, based on their July market

Table 20—Allocation of necessary reserves to the three cooperatives based on market shares

Month	Market	Cooperative No. 1	Cooperative No. 2	Cooperative No. 3
		Million pounds		
January	27.218	13.598	8.171	5.449
February	27.720	13.778	8.398	5.544
March	41.726	21.367	12.171	8.188
April	52.260	27.090	15.102	10.068
May	54.746	28.139	15.844	10.763
June	55.620	29.496	15.310	10.814
July	44.268	22.288	13.136	8.844
August	35.805	17.412	11.081	7.312
September	22.620	11.082	6.922	4.616
October	19.592	9.461	6.129	4.002
November	15.600	7.485	4.929	3.186
December	23.064	10.944	7.358	4.762
Total	420.239	212.140	124.551	83.548

shares. Therefore, cooperative No. 1 has a total claim of 27.852 million pounds on the reserve-balancing pool, which amounts to $26,631. For cooperative No. 2, the total claim is 16.416 million pounds, or a sum of $15,697 on the July reserve-balancing pool. Of course, cooperative No. 3 receives no pool credit because it does not perform reserve-balancing services during the pool formation period. Pool payments for other months can be calculated in the same manner.

Table 21—Calculating payments to cooperatives for supply-balancing services based on market shares

Month	Balancing cost deduction per unit of fluid milk	Total balancing cost deduction from the market-wide producer pool	Payments for balancing services: Cooperative No. 1	Cooperative No. 2	Cooperative No. 3	Payment per unit of necessary reserves
	Cents/cwt.		*Dollars*			*Cents/cwt.*
January	7.1	113,958	56,933	34,211	22,814	41.9
February	6.3	90,090	44,779	27,293	18,018	32.5
March	3.4	52,800	27,038	15,401	10,361	12.7
April	.6	8,198	4,250	2,369	1,579	1.6
May	.4	6,258	3,217	1,811	1,230	1.1
June	0	0	0	0	0	0
July	3.0	42,328	21,311	12,560	8,457	9.6
August	5.3	78,296	38,076	24,231	15,989	21.9
September	8.0	124,134	60,816	37,986	25,332	54.9
October	8.8	140,340	67,770	43,903	28,667	71.6
November	9.3	144,726	69,441	45,728	29,557	92.8
December	8.2	129,406	61,404	41,284	26,718	56.1
Total	[1]5.1	930,534	455,035	286,777	188,722	[1]22.1

[1]Weighted average.

Table 22—Calculation of claims on reserve-balancing pool based on volume of necessary reserves manufactured during the pool formation period

Month	Cooperative No. 1			Cooperative No. 2			Cooperative No. 3		
	Volume manufactured	Necessary reserves	Manufacturing overage	Volume manufactured	Necessary reserves	Manufacturing overage	Volume manufactured	Necessary reserves	Manufacturing overage
	Million pounds								
April	119.064	27.090	91.974	57.936	15.102	42.834	0.0	10.068	-10.068
May	121.331	28.139	93.192	64.669	15.844	48.825	0.0	10.763	-10.763
June	117.426	29.496	87.930	64.074	15.310	48.764	0.0	10.814	-10.814
Total	357.821	84.725	273.096	186.679	46.256	140.423	0.0	31.645	-31.645
	Percent								
Claim on own share of necessary reserves[1]		100.0			100.0			0	
Own share of necessary reserve ceded to the remaining of reserve-balancing pool		0			0			100.0	

[1]It is 100 percent if pooled milk manufactured at the cooperative's plant(s) is more than the volume of necessary reserves allocated to the cooperative.

Item	July	August	September	October	November	December	January	February	March	Total
					Million pounds					
Necessary reserves credited to:										
Market (reserve-balancing pool)	44.268	35.805	22.620	19.592	15.600	23.064	27.218	27.720	41.726	257.613
Cooperative No. 1, 100 percent own share	22.288	17.412	11.082	9.461	7.485	10.944	13.598	13.778	21.367	127.415
Cooperative No. 2, 100 percent own share	13.136	11.081	6.922	6.129	4.929	7.358	8.171	8.398	12.171	78.295
Remaining reserve-balancing pool not otherwise claimed:										
Ceded by Cooperative No. 3 (or independent producers as a group)	8.844	7.312	4.616	4.002	3.186	4.762	5.449	5.544	8.188	51.903
Credited to cooperative No. 1 based on market share	5.564	4.468	2.841	2.429	1.921	2.848	3.404	3.445	5.217	32.137
Credited to cooperative No. 2 based on market share	3.280	2.844	1.775	1.573	1.265	1.914	2.045	2.099	2.971	19.766
Total volume of necessary reserves credited to:										
Cooperative No. 1	27.852	21.880	13.923	11.890	9.406	13.792	17.002	17.223	26.584	159.552
Cooperative No. 2	16.416	13.925	8.697	7.702	6.194	9.272	10.216	10.497	15.142	98.061
					Dollars					
Reserve-balancing credit to:										
Cooperative No. 1	26,631	47,846	76,407	85,170	87,262	77,383	71,185	55,975	33,639	561,498
Cooperative No. 2	15,697	30,450	47,727	55,170	57,464	52,023	42,773	34,115	19,161	354,580

Table 23—Distribution of necessary reserves and reserve-balancing credits to cooperatives based on market shares

CONCLUSION

The main feature of the reserve-balancing pool proposed in this report for sharing the costs of balancing milk supplies for the fluid market is that it is performance-oriented. For a cooperative to establish its claim on the reserve-balancing pool, it must deliver milk for fluid uses and manufacture the volume of reserves that is necessary but unused for fluid purposes, when such volume is the highest during the pool formation period. To actually receive pool credits during the pool payment period, the cooperative also must deliver milk for fluid uses, because pool payment is based on the volume of necessary reserves balanced by the cooperative, which is a certain (albeit varying from month to month) percentage of the fluid volume.

The approach is to deal with the issue of supply balancing from the viewpoint of servicing the needs of the fluid market and sharing the costs of providing the services. The volume of operating reserves and seasonal reserves is necessary to ensure sufficient milk supply for fluid uses year-round. It is the minimum volume of reserves that fluid handlers have to carry if they procure their own milk and balance their own supplies, but is now carried by dairy cooperatives. During the reserve-balancing pool formation period, the volume of necessary reserves serves as the yardstick of measuring a cooperative's performance in balancing milk supply for the fluid market. The volume of necessary reserves also is the basis for establishing a cooperative's claim to the reserve-balancing pool. If a cooperative does not fully perform its share of balancing services required by its presence in the fluid market, its claim on the pool is reduced. If a cooperative takes on more than its share of balancing necessary reserves, its claim on the pool may be increased. If all cooperatives in the market collectively do not balance as great a volume of necessary reserves as is expected of them, the size of the reserve-balancing pool during the subsequent pool payment period may be reduced.

In the actual applications of the reserve-balancing pool in some markets, commingling of milk at the plants may make it impractical to trace uses of milk delivered by each cooperative.

Allocation of the volume of necessary reserves to each cooperative may be based on a cooperative's market share of milk delivered to the market for fluid and other uses.

The reserve-balancing pool does not attempt to compensate to the last dollar the costs a dairy cooperative may incur in its supply-balancing plant operations. When the costs of balancing necessary reserves are calculated, the calculation should be based on the optimal scale of a manufacturing plant that would enable least-cost, most efficient plant operations. This provides an incentive for a cooperative to operate its plant(s) most efficiently if it intends to recover its supply-balancing costs from the pool, if and when such a pool is instituted.

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*U.S. Government Printing Office: 1985 0 528-663 (30801)

U.S. Department of Agriculture
Agricultural Cooperative Service
Washington, D.C. 20250

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